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JUL 7 1986

~~JTB 06/03/86 M1 GREEVES~~

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MEMORANDUM FOR: John T. Greeves, Chief  
Engineering Branch  
Division of Waste Management

THRU: Mysore S. Nataraja  
Engineering Branch  
Division of Waste Management

FROM: John T. Buckley  
Engineering Branch  
Division of Waste Management

SUBJECT: IN SITU STRESS STATE AT BWIP SITE

WM Record File

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(Return to WM, 623-SS)

At your request we have prepared the following summary of facts concerning the status of the in situ stress issue at the BWIP site.

During the past three months the on-site licensing representative (OLR) at BWIP, Robert Cook, has raised several concerns regarding the state of in situ stress at the BWIP site. In his April 7, 1986 memorandum to Robert Browning, Cook makes the following statements:

1. "It appears obvious to me that in situ stress is a key parameter required to make design and siting decisions".
2. "To date it is not clear to me that siting decisions have adequately and objectively considered this parameter and it appears that DOE has in effect tabled the resolution of the issue considering the inaction on the RHO proposals".
3. "Based on knowledge of diskings and spalling, both qualitatively indicative of high stresses, and stresses deduced from hydro-fracturing tests, I believe the present location of the RRL is undesirable compared to locations further away from the Cold Creek Syncline axis and the fault which is associated with the hydraulic barrier to the west."

In his May 8, 1986 memorandum to Robert Browning, Cook made the following statement: "As I emphasized ... I consider the issue of what is the magnitude and direction of in-situ stresses at the RRL and how these stresses relate to practical and acceptable conditions for geologic repository operations area siting, construction and operation, as well as, the geologic repository functional capabilities, of highest technical priority."

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During his visit to the NRC Headquarters on April 16, 1986, Cook discussed the in situ stress issue with Mysore Nataraja and John Buckley. During the discussion, Cook was informed of numerous occasions during which the NRC staff had raised these very concerns to DOE/BWIP. Later, during a telephone conversation among Cook, Nataraja, and Buckley, a related discussion came up. It was apparent from one of Cook's comments that there is confusion in his mind over the deformation and failure patterns of a borehole due to stresses, as deduced from assumptions of linear elasticity.

Cook is correct in saying that in situ stress is a key design parameter. As mentioned earlier, the staff has long recognized the problems associated with high in situ stress and raised these issues with the DOE on numerous occasions during the past five years. The significance of core diskings which is related to the high state of stress (and often times associated with rock bursting) was pointed out by the NRC in 1981 (Ref. 1). The importance of an inferred stress field was discussed with the DOE at a technical meeting on October 5-6, 1982, (Ref. 2). Since 1981 the NRC has raised many issues associated with high horizontal stress levels at BWIP. In November, 1983, the NRC participated in an Exploratory Shaft Test Plan Workshop at Hanford. Problems associated with high in situ stress were discussed with the DOE/BWIP at this workshop. Additionally, staff and contractor comments on the Exploratory Shaft Test Plan were transmitted to the DOE/BWIP in a follow-up letter dated March 18, 1984, from Wright to Olson (Ref. 3). In this letter the NRC identified that high in situ stress could present problems during ES construction activities and recommended monitoring the liner throughout the testing period. In a May 22, 1984, letter from Wright to Olson, the staff expressed an increased concern about constructibility of a repository and retrievability of waste canisters due to new evidence (spalling boreholes as seen in video tapes during the January 23-27, 1984 data review) indicating high horizontal stresses. Furthermore, the staff stated that peer review of hydro-fracture test results may be appropriate (Ref. 4)\*. Concerns were also raised in NRC's comments on the draft EA about the ability to construct a shaft and maintain stable openings in the presence of high in situ stresses (Ref. 5).

\*It was learned recently that the BWIP did take the NRC's recommendation and put together a panel of experts to review the existing information related to the state of in situ stress at the BWIP site and make recommendations for further work. The OLR has just sent a copy of the panel report for NRC staff review (Ref. 12). The review of this report is currently underway, the preliminary findings will be discussed at the end of this memo.

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As evidenced by several technical discussions among the staff and NRC contractors, the staff is aware of constructibility, cost and schedule problems associated with the presence of high in situ stresses at BWIP, and has used every opportunity to pass on our concerns to BWIP/DOE in a constructive manner.

It is clear that the DOE did not weigh in situ stress conditions heavily in the siting of the reference repository location (RRL) at the Hanford site, mainly because reliable stress information was not available at the time (Ref. 6). BWIP produced two documents concerning the siting of the RRL (Ref. 6 and Ref. 7). The NRC did not identify any new major issues in its review of these documents and therefore did not submit formal comments to the DOE. Furthermore, in a response to a congressional request for information (6/28/84) the staff responded by stating that it is not a usual engineering practice to assign a disqualifying horizontal to vertical stress ratio value for the purposes of design and construction. Stress ratio is considered one of a number of key design parameters. Repository construction and operation may be affected by high in situ stresses depending upon the local rock strength and joint properties (Ref. 8).

DOE has proposed, in their draft test plan (Ref. 9), additional in situ stress data gathering during site characterization. The NRC staff believes that the DOE now recognizes the need for this additional data. However, according to Cook the DOE has not responded to a Rockwell request for additional hydro-fracture testing and additional comprehensive analyses in two boreholes located to the southeast of the RRL, boreholes DC-8 and DC-12 (Ref. 10). The staff will take a position on whether this particular additional hydro-fracture testing and proposed analyses are necessary after reviewing DOE's test plan (integrated plan which will describe underground as well as surface based testing, if any).

As stated above the staff has been aware of the presence of core diskings and borehole wall spalling and recognizes the correlation between diskings, spalling and high horizontal stress. Although a repository site with a lower horizontal stress field would be more desirable, the staff does not have evidence that shows it is mandatory for DOE to change site locations based on what is known at the BWIP site. A recent DOE document provides data indicating that the magnitude of the horizontal stress field is comparable inside and outside of the RRL (Ref. 11). This report is currently being reviewed by the NRC staff and contractors. This report apparently incorporates the comments made by the panel of experts (Ref. 12) who met in Rapid City, South Dakota to discuss the state of in situ stress and rock mass strength characteristics at the BWIP site. The NRC staff will review this panel report in detail. A preliminary

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review indicates that the panel of experts clearly concludes in its review of existing data that the current state of knowledge is acceptable for the preliminary designs and that additional work is desirable to increase confidence in the data gathered to date. The panel's view is essentially consistent with the NRC staff view regarding the adequacy of the in situ stress data.

In summary, Cook is correct in identifying the high in situ stress conditions at the BWIP site as an important technical issue, a fact recognized by the staff for quite some time. Furthermore, the staff has continuously reviewed the in situ stress data available over the last five years and has not been able to identify this as a fatal flaw based on the evidence presented. The record clearly shows that the staff has raised this issue repeatedly with DOE, and will continue to follow it closely. The Rock Mechanics/Design team members have a plan to visit BWIP and the Lucky Friday Mine in the Coeur d' Alene mining district with their consultants after the review of the FEA's (There are many similarities in the high stress conditions found in this mine and at the BWIP site. Core diskings and borehole spalling have been observed in the jointed rock and severe rock bursting conditions have been encountered here). At the time of the mine visit, all of the available data will be reviewed. If you wish further information on this issue please discuss with us.

ORIGINAL SIGNED BY  
Mysore S. Nataraja

*for* John T. Buckley  
Engineering Branch  
Division of Waste Management

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OFFICER :	WMEG	:	WMEG	:	:	:	:	:
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